Droplet Transport on a Discrete Wettability Gradient Surface: Role of Droplet Weber Number

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Abstract

Understanding droplet motion on wettability gradient surfaces has received considerable academic interest in the context of controlled motion of droplet liquid in a specified direction in micro-scale devices such as biochips. The present work deals with the impact of water droplets of low Weber number (*We*) onto solid surfaces comprising of a discrete gradient of roughness (and hence wettability). Two stainless steel solid surfaces – TGS1 and TGS2 – each comprising of a smooth and a parallel groove-textured portion and differing only in the geometry of the textured portion were used. Water droplets of diameter ~ 2.6 mm were impacted onto the interface of the roughness gradient from different heights simulating different *We*. Bulk droplet motion perpendicular to the groove direction was considered. The outcomes of the droplet impact experiments were elucidated in terms of factors significant from the point-of-view of droplet transport: (1) the final horizontal distance moved by the droplet from the impact point, (2) the final contact diameter of the droplet, (3) receding intensity of the droplet fronts on either sides of the interface, and (4) amplitude of droplet oscillations at the final stage of droplet transport. With an increase in impact *We* all the above-mentioned droplet transport parameters deteriorated for both the surfaces indicating a less efficient droplet transport at higher impact Weber numbers. This can be understood qualitatively via energy considerations. Moreover, for a given impact condition, the droplet transport parameters were found to be superior in the case of TGS2 surface. Attempts were made to explain this behavior in terms of the relative magnitude of wettability gradient (or the difference between the equilibrium contact angles of water on smooth and textured portions) and contact angle hysteresis on these solid surfaces.

Key words: Wettability gradient, droplet transport, droplet impact

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